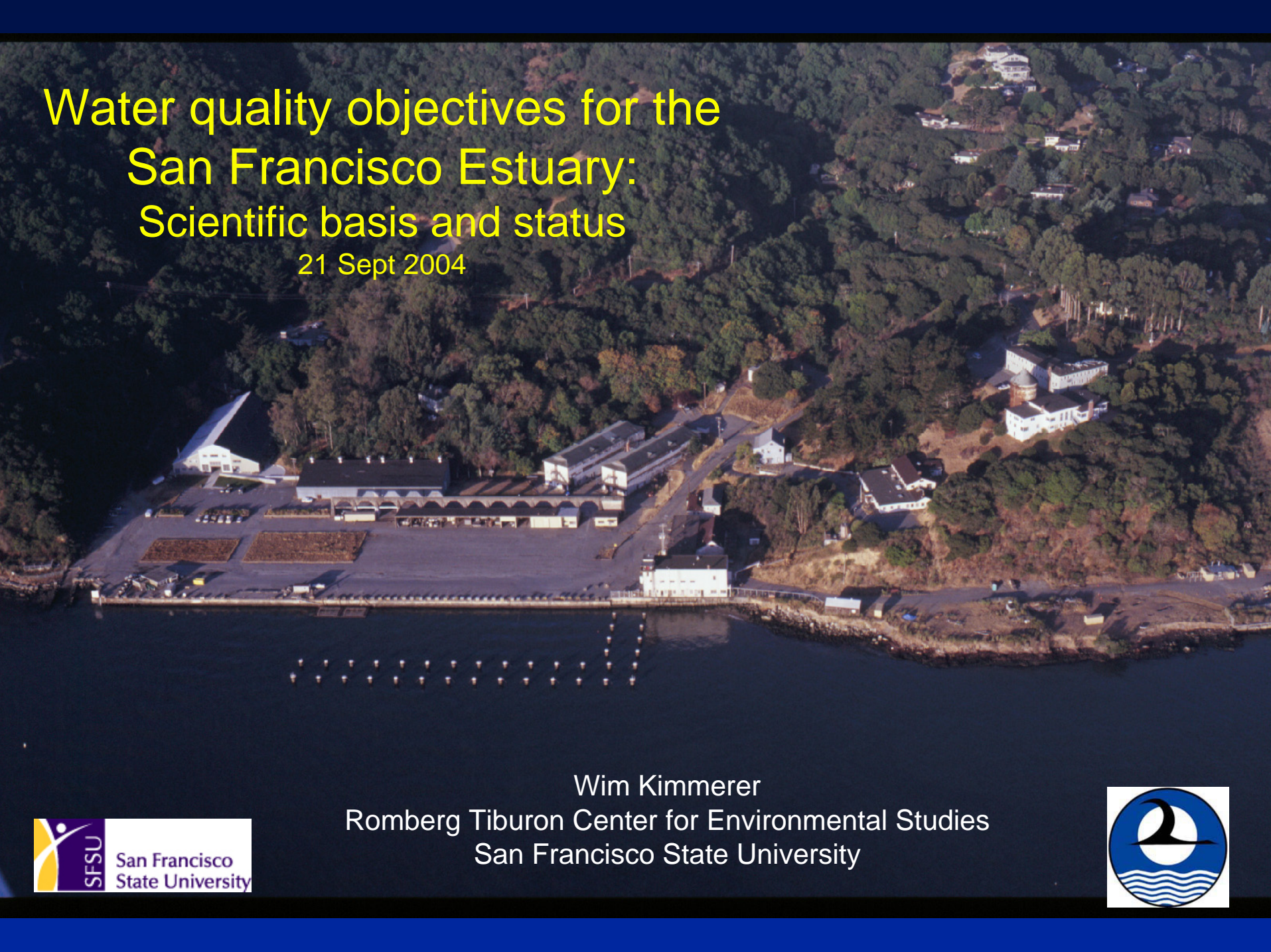


Water quality objectives for the San Francisco Estuary: Scientific basis and status

21 Sept 2004



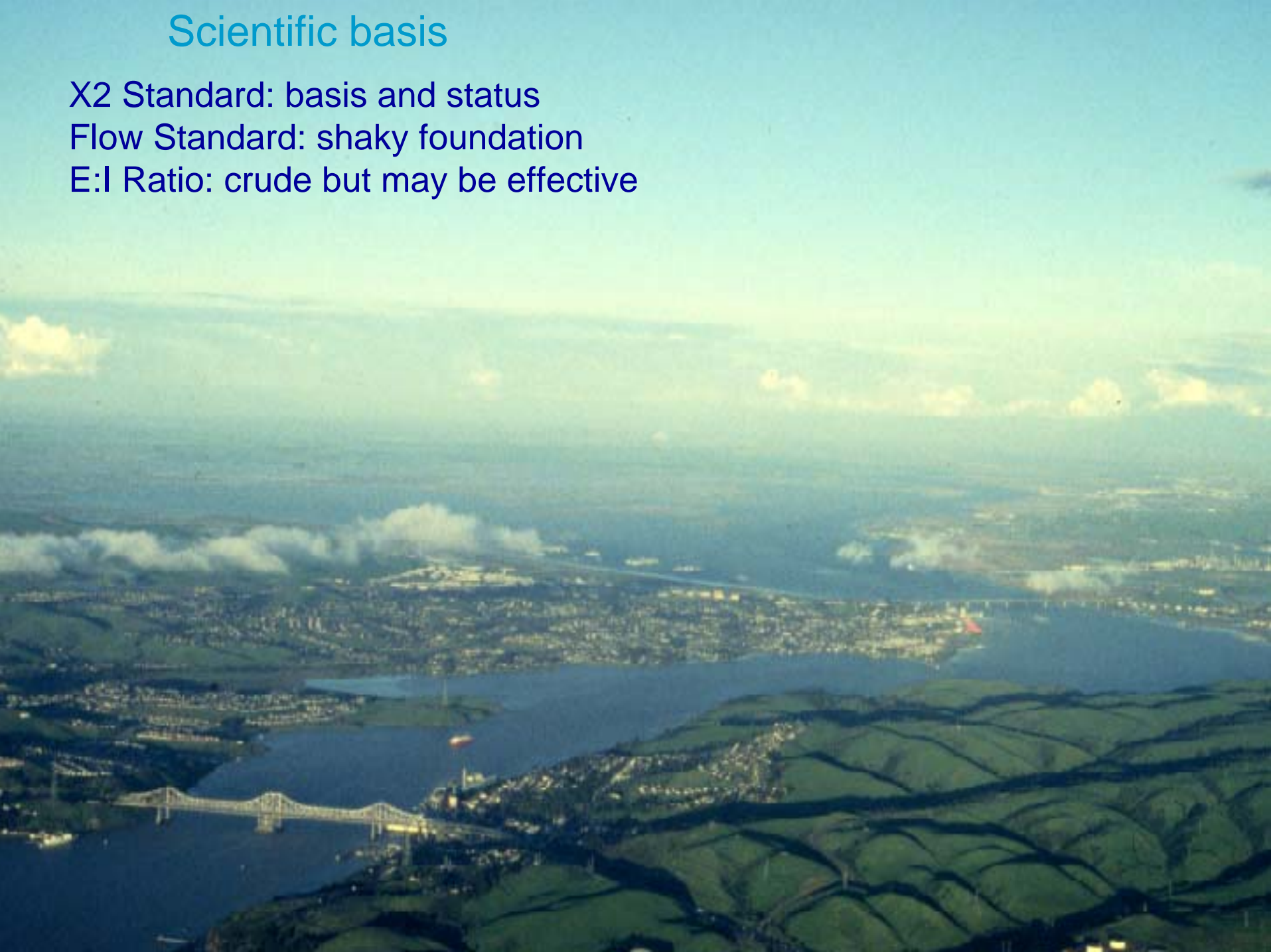
Wim Kimmerer
Romberg Tiburon Center for Environmental Studies
San Francisco State University

Scientific basis

X2 Standard: basis and status

Flow Standard: shaky foundation

E:I Ratio: crude but may be effective



Low Abundance

Low-salinity zone in deep delta channels



Defining X_2 -
Salinity field or
shallow habitat?



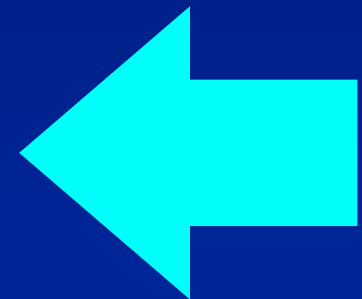
$100 \text{ m}^3 \text{ s}^{-1}$
(3500 cfs)

High Abundance

Low-salinity zone in shallow Suisun Bay



Freshwater Flow

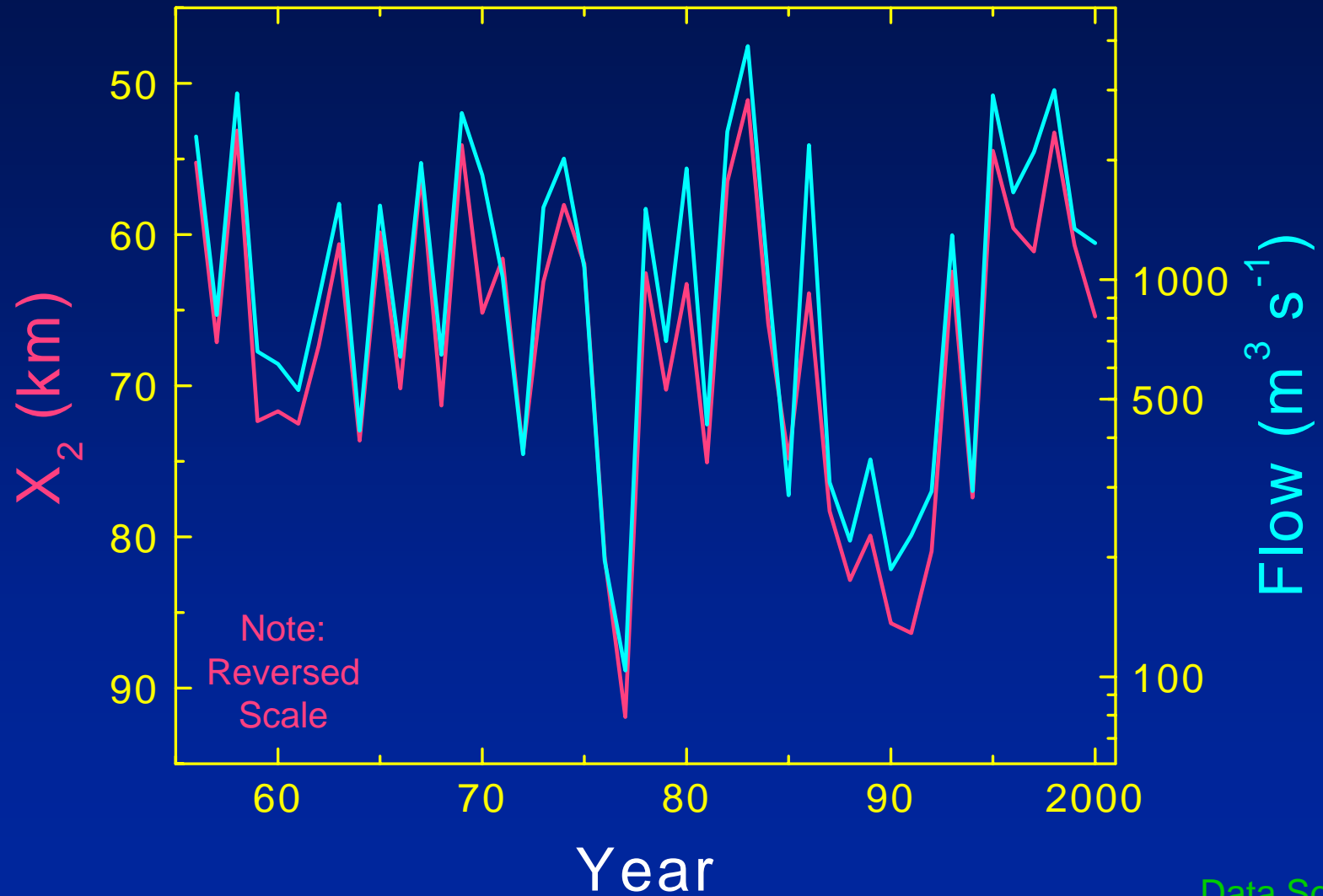


$1000 \text{ m}^3 \text{ s}^{-1}$
(35,000 cfs)

Suisun Bay

Delta

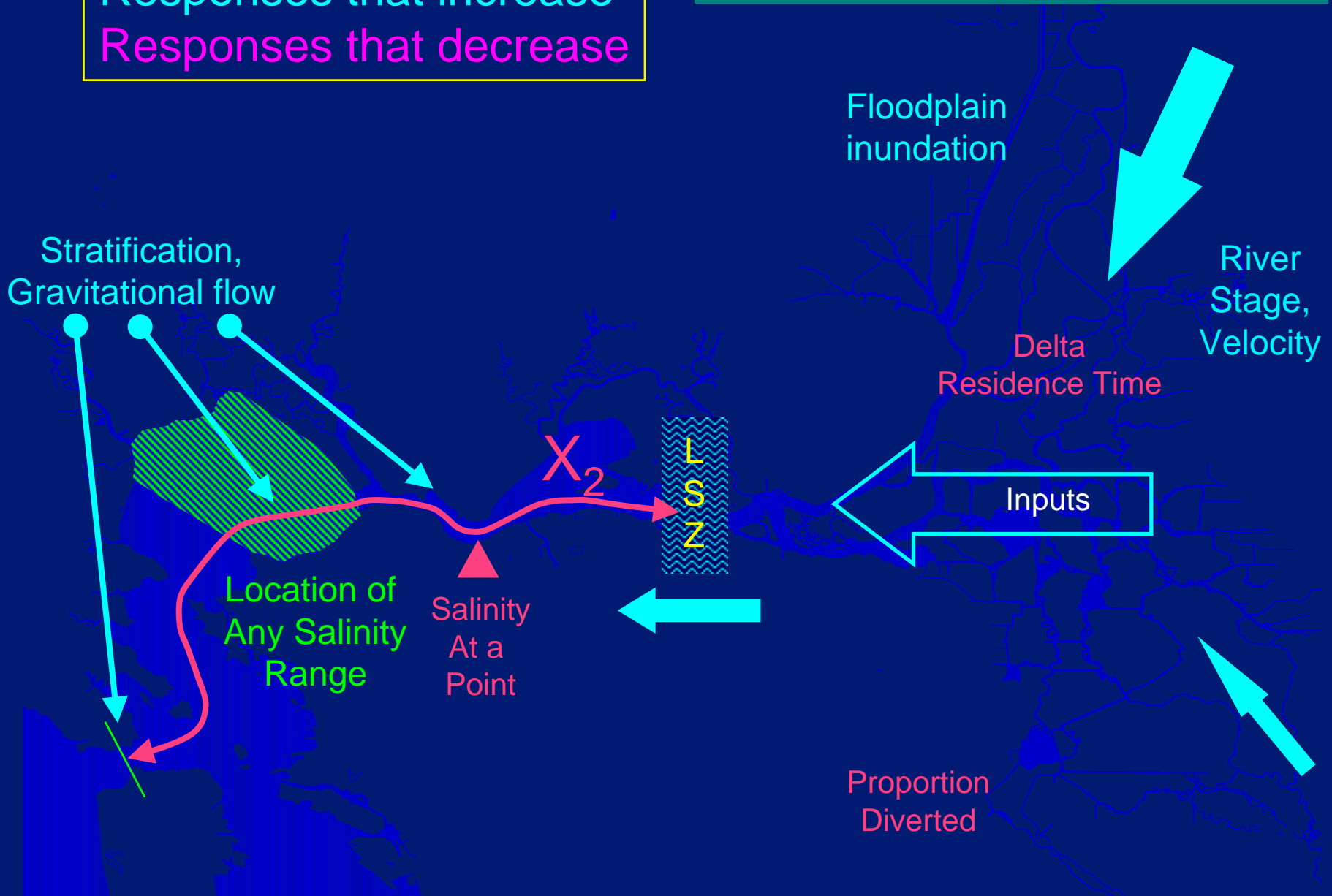
Freshwater Flow and X_2 Inversely Related



Data Source:
DAYFLOW, X2 Model

What Changes As Freshwater Flow Increases?

Responses that increase
Responses that decrease



Key facts about X_2

- X_2 is a measure of the physical response of the estuary to freshwater flow

Tidal influences dominate estuarine flow patterns

Freshwater affects estuary indirectly through salinity

Salinity pattern changes more slowly than flow

- X_2 is closely correlated with freshwater flow

Flow causes the salinity gradient to move

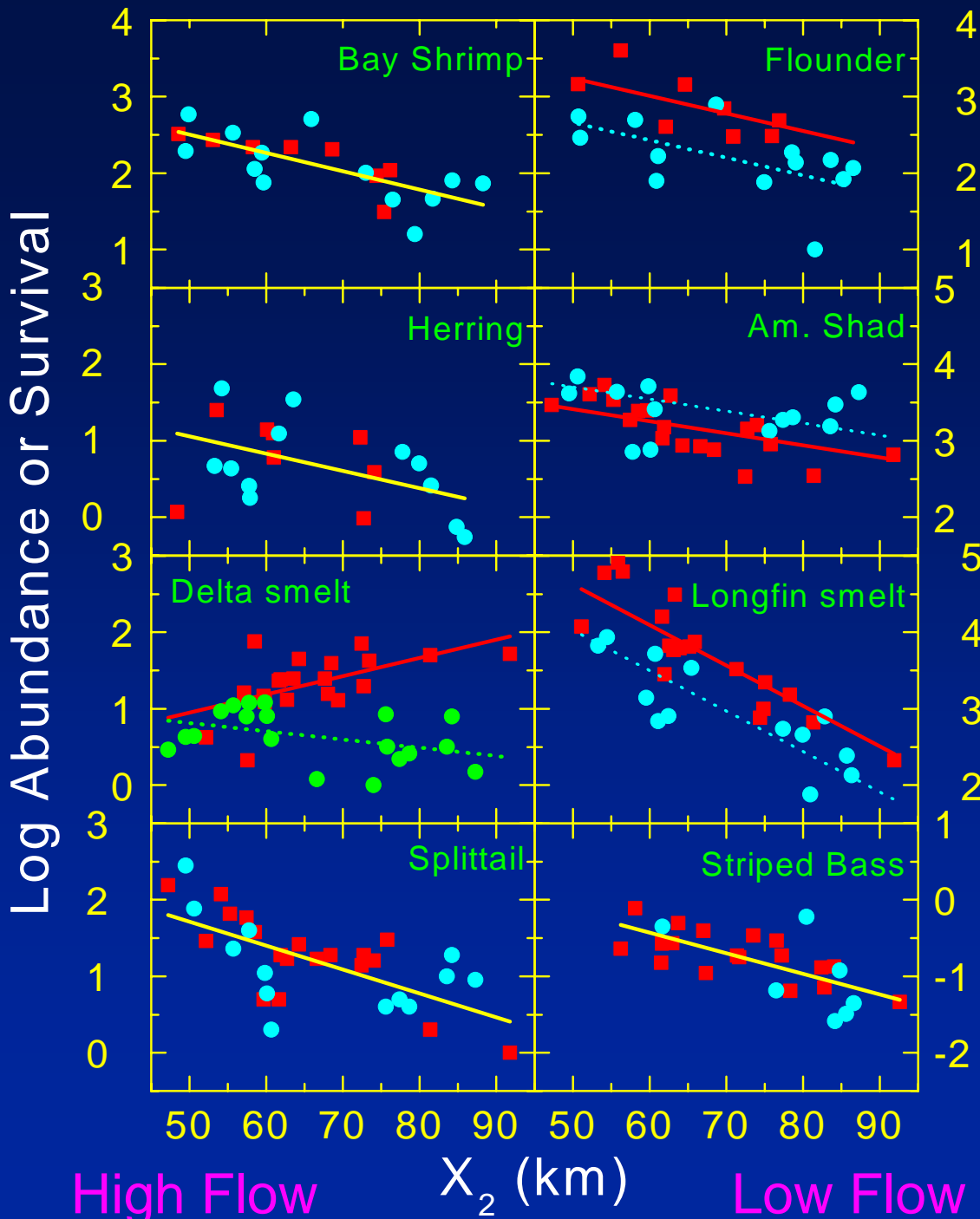
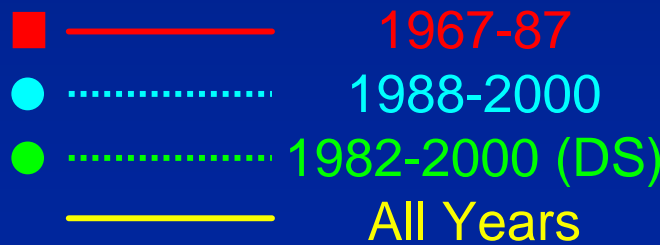
Flow and X_2 are statistically equivalent

- Many species vary with freshwater flow and X_2

More flow means more fish

Causes of this pattern vary with species

Relationships Between Freshwater Flow and Biological Populations



Potential Causes of X_2 Relationships

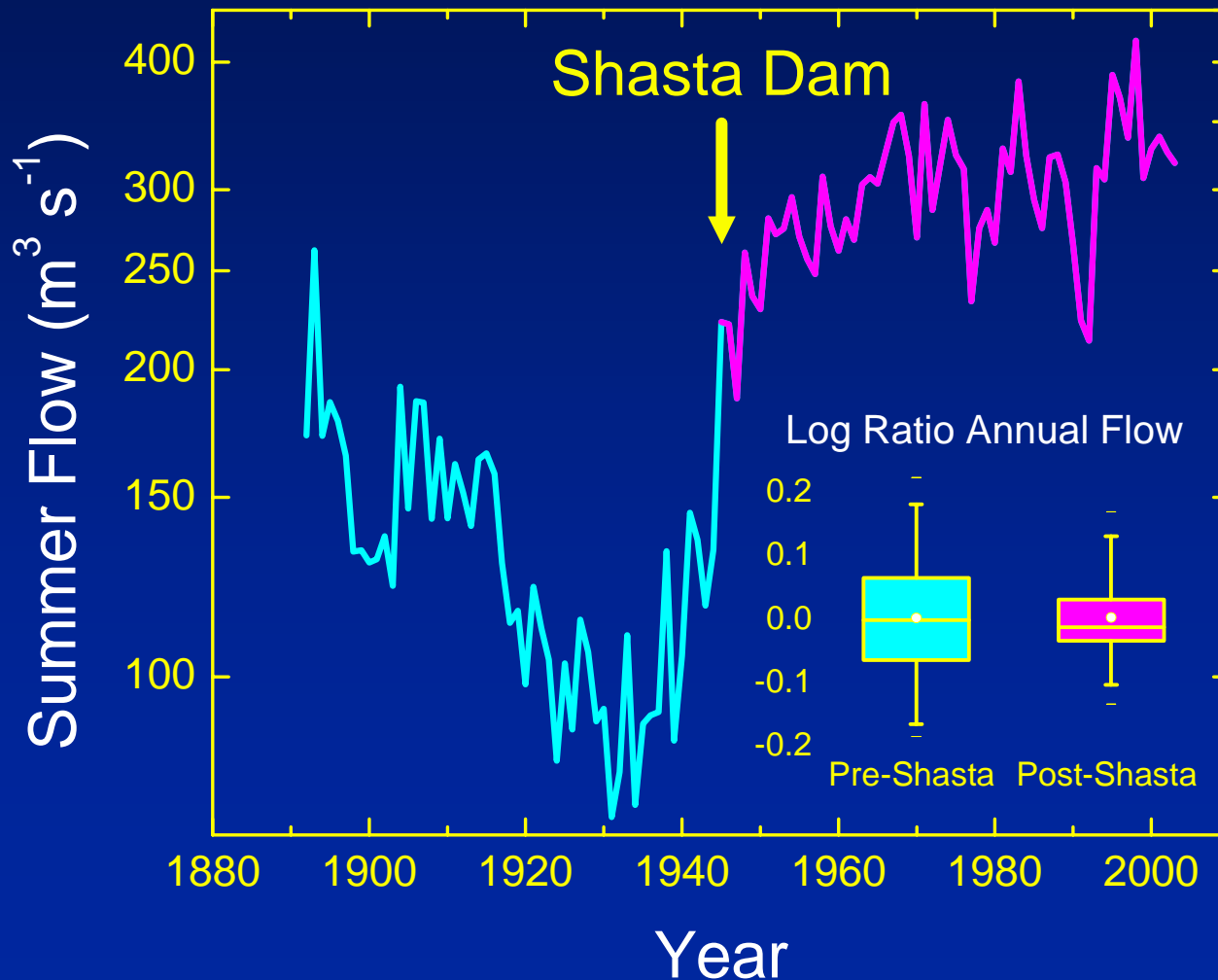
- Transport and Entrainment
 - Rapid transport from Delta may be beneficial
- Input of food
 - Flow could stimulate foodweb
- Habitat Space
 - More space may become available at high freshwater flow
- Circulation
 - Flow patterns enhance up-estuary transport

Flow standard

- Applies when X_2 is not in effect
- What is the basis?
 - Fish- X_2 relationships are mostly for spring
- Delta probably became salty in pre-dam summers

Variability in Summer Flow has Decreased

Mean flow at Red Bluff for July – September

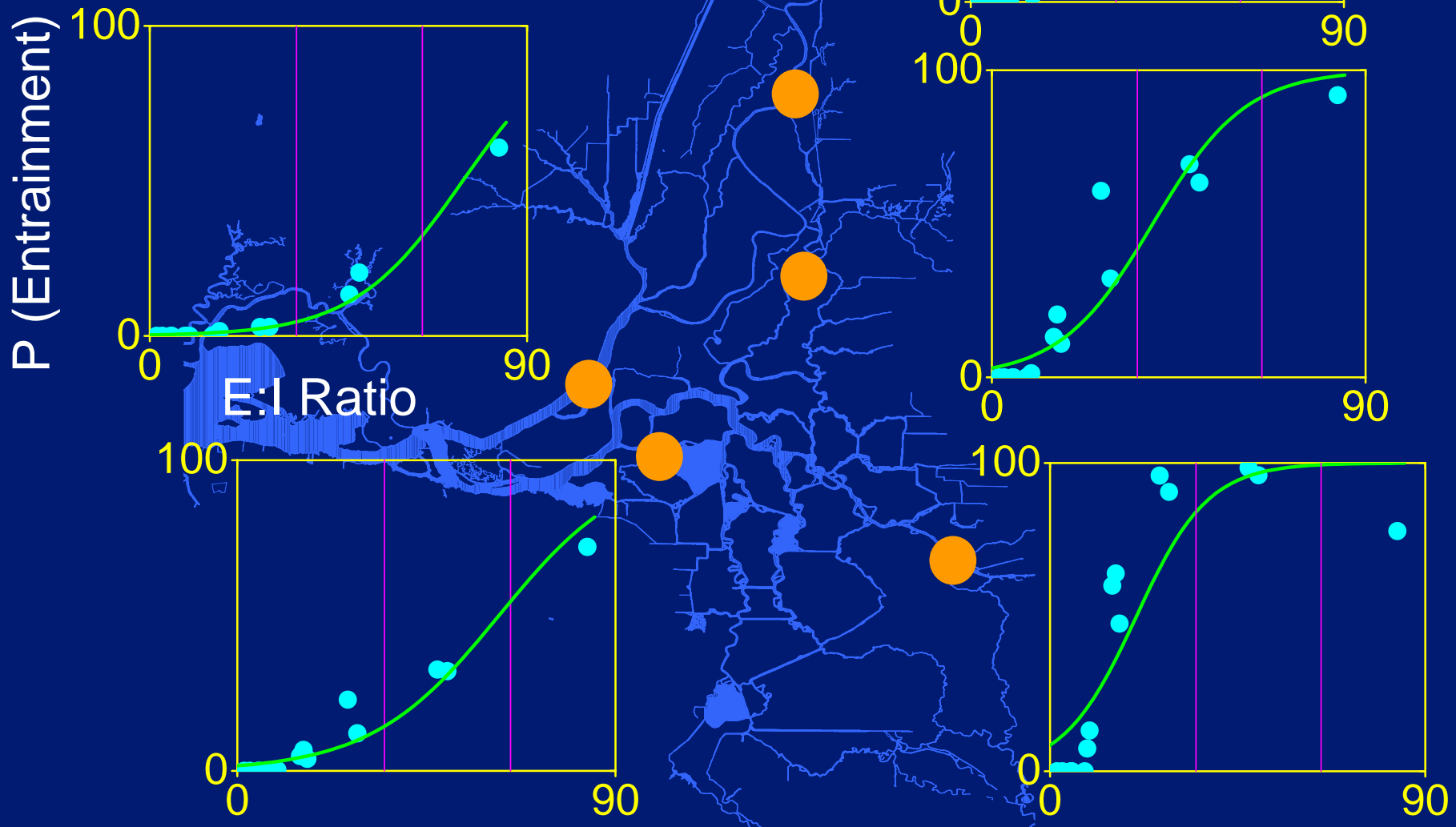


Flow standard
enforces further
reduction in variability
in summer

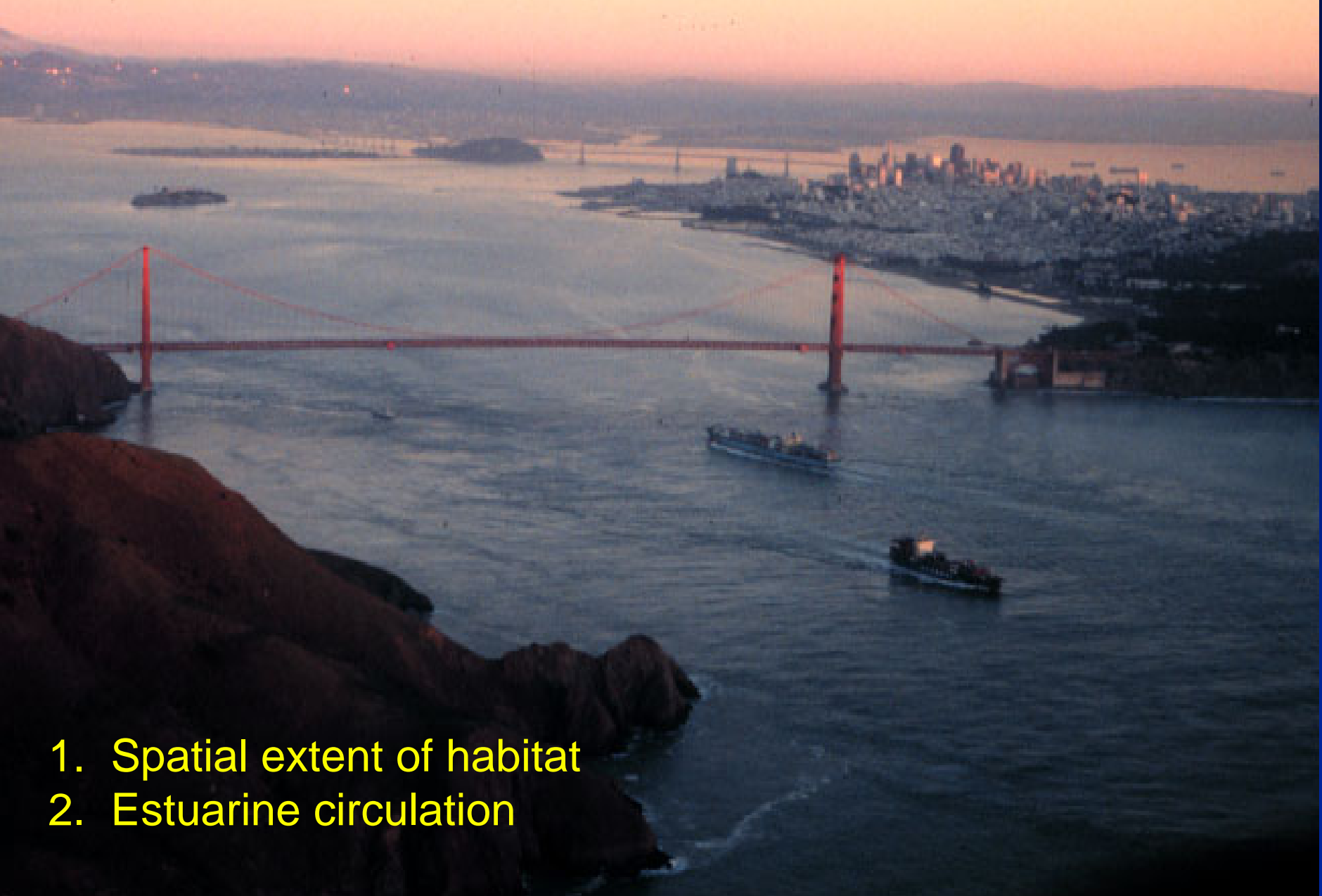
Data Source:
USGS Flow Data

E:I Ratio and probability of entrainment

Particle tracking model with spring tides,
constant flows, 90 day time period



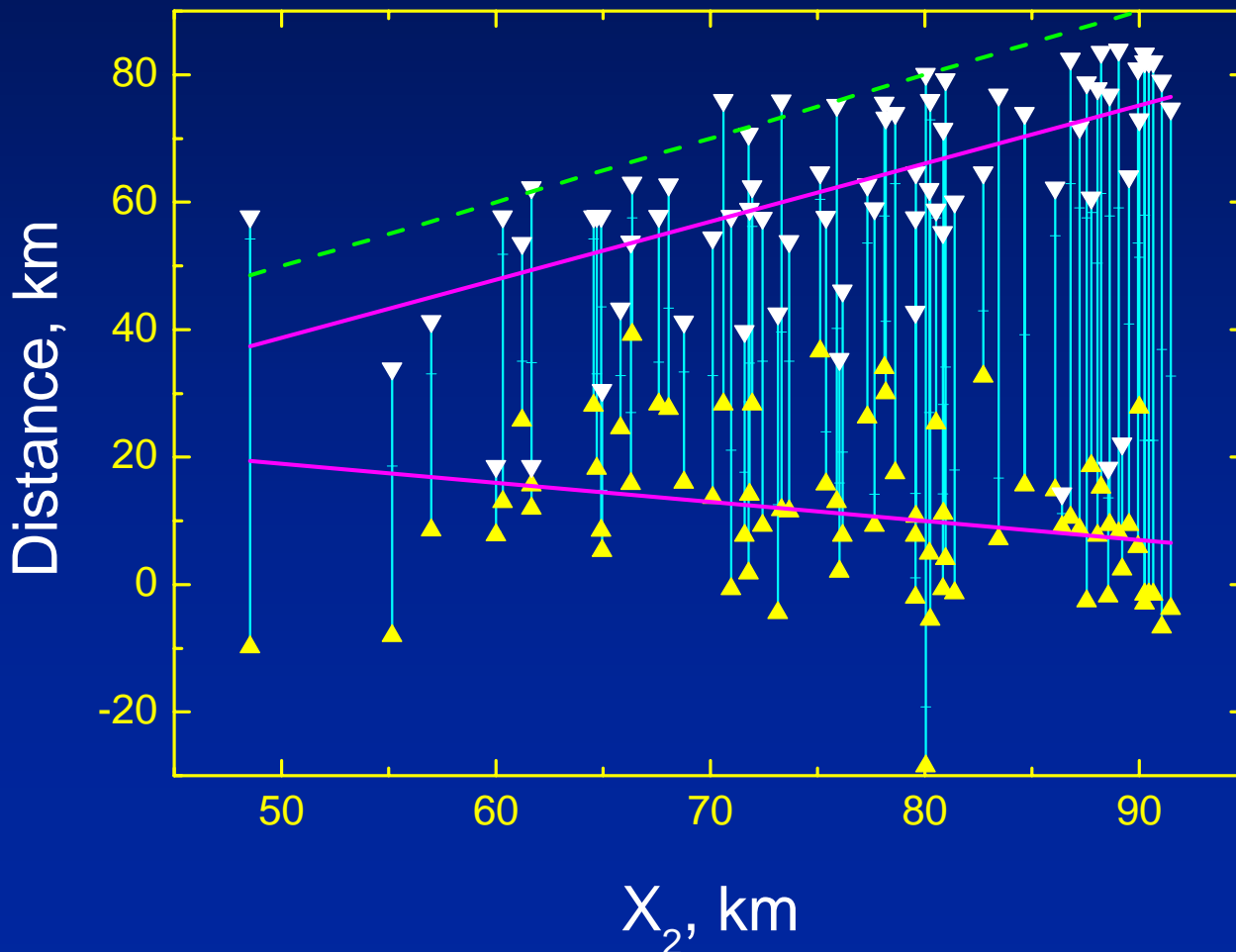
Examples of potential X_2 mechanisms



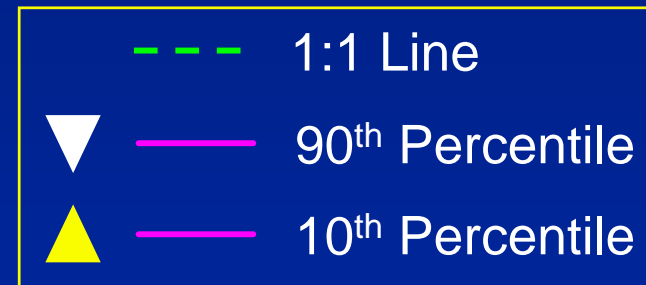
1. Spatial extent of habitat
2. Estuarine circulation

Mechanism: increasing habitat space with seaward X_2

Spatial extent of longfin smelt



Smelt population is
more compressed
when X_2 is seaward;
does not support
mechanism



Data Source:
SF Bay Study

Ocean

Estuary

High Abundance with
High Freshwater Flow
due to Gravitational Flow

Low Flow

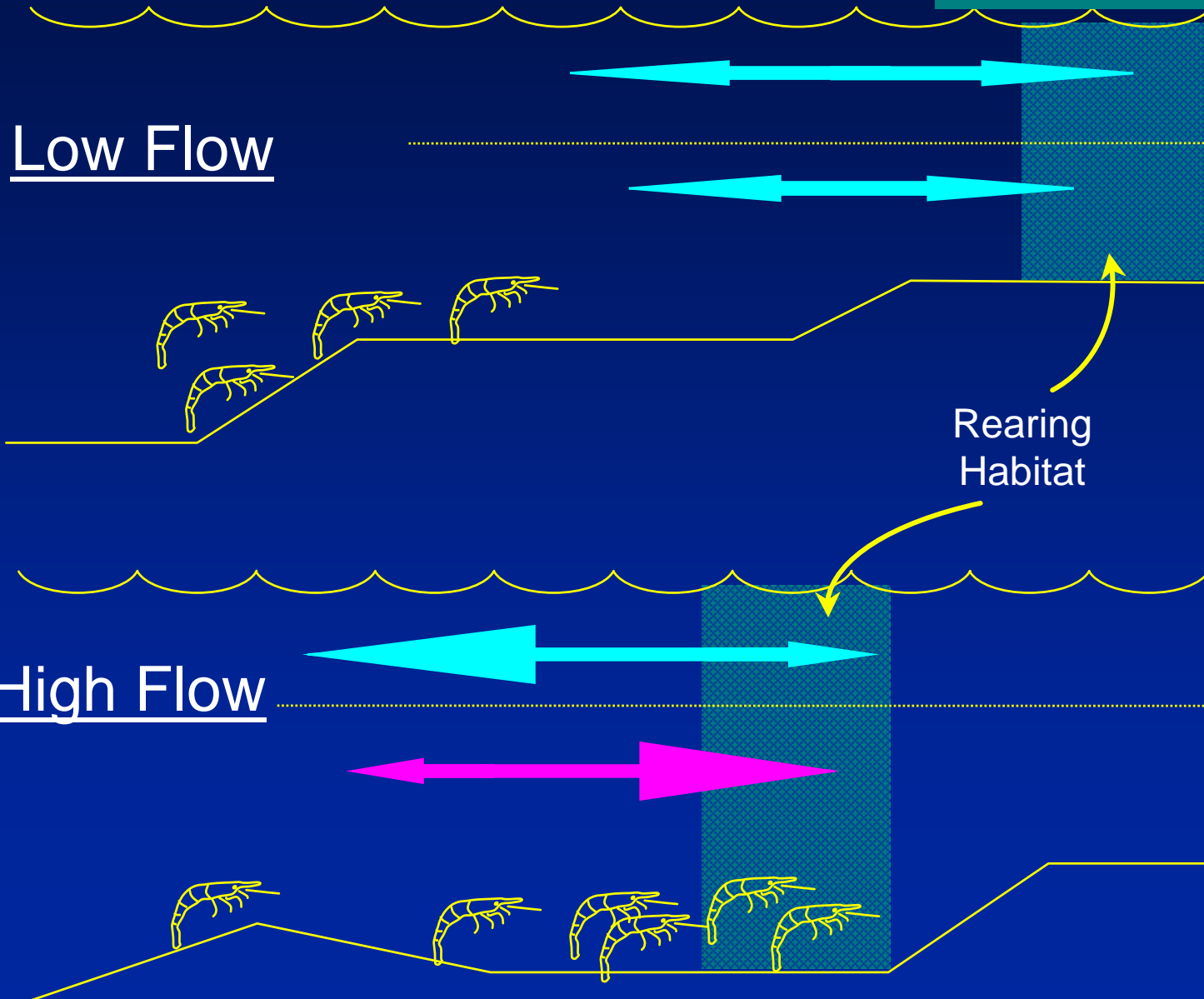
Tidal currents

Rearing
Habitat

When freshwater flow is high, more
salty water comes
into the estuary
near the bottom.

High Flow

Some species may
enter the estuary
more rapidly and
become more
abundant.



Research Program

- Current phase
 - Simulation modeling
 - Variation in habitat area with flow
 - Variation in gravitational circulation
 - Retention of planktonic organisms
 - Planning for subsequent phases
- Future work (e.g.)
 - Compare delta smelt and longfin smelt
 - Detect and quantify larval inputs
 - Field work to follow up on modeling results